CLAIMS

1. Apparatus for ultrasound imaging comprising:

a signal generator;

a transmit transducer coupled to the signal generator for simultaneously irradiating a target with a relatively low frequency ultrasound conditioning signal and a relatively high frequency ultrasound detection signal;

a receive transducer for receiving echo signals from the target; and

a signal processor adapted to process the received echo signals to detect the presence of first structures within the target causing a first magnitude of detection signal echo arising from periods when the conditioning signal is in a first phase and a second, different, magnitude of detection signal echo arising from periods when the conditioning signal is in a second phase.

2. The apparatus of claim 1 in which the signal processor is adapted to process the received echo signals so as to differentiate said first structures within the target whose physical properties change as a function of the conditioning signal from second structures whose corresponding physical properties remain substantially invariant in response to the conditioning signal.

3. The apparatus of claim 1 or claim 2 in which the conditioning signal has a frequency in the range 10 kHz to 5 MHz.

4. The apparatus of claim 3 in which the conditioning signal has a frequency in the range 100 kHz to 800 kHz.

5. The apparatus of any one of claims 1 to 4 in which the detection signal has a frequency in the range 1 MHz to 50 MHz.

6. The apparatus of claim 5 in which the detection signal has a frequency in the range 1 MHz to 5 MHz.

7. The apparatus of any one of claims 1 to 6 in which the signal processor is adapted to determine the response of the first structures to the detection signal during positive and negative cycles of the conditioning signal.

8. The apparatus of any one of claims 1 to 6 in which the signal generator and transmit transducer are adapted to produce a first excitation signal pulse and successively a second excitation signal pulse that is a phase-inverted replica of the first excitation signal pulse; and

in which the signal processor includes means for processing the received echo signals to determine the response of the first structures to the first and second excitation signal pulses.

9. The apparatus of claim 8 in which the first and second excitation signal pulses comprise the conditioning signal.

10. The apparatus of claim 8 or claim 9 in which the first and second excitation signal pulses comprise the detection signal.

11. The apparatus of any preceding claim in which the transmit transducer is adapted to transmit at least a first excitation pulse and a second excitation pulse each including a said conditioning signal frequency and a said detection signal frequency, the second excitation pulse being a phase inversion of the first excitation pulse; and

in which the signal processor comprises a pulse inversion processor for determining a difference between an echo signal from the first excitation pulse and an echo signal from the second excitation pulse.

12. The apparatus of any one of claims 1 to 10 in which the transmit transducer is adapted to transmit at least a first excitation pulse and a second excitation pulse each including a said conditioning signal frequency and a said detection signal frequency, the second excitation pulse being a phase shifted version of the first excitation pulse; and

in which the signal processor comprises a correlation processor for determining a difference between at least portions of an echo signal from the first excitation pulse and an echo signal from the second excitation pulse.

13. The apparatus of any preceding claim further including an image display system adapted to indicate locations of the first structures within the target.

14. The apparatus of claim 2 further including an image display system adapted to indicate relative locations of the first and second structures within the target.

15. The apparatus of any preceding claim in which the signal processor is adapted to process one or more harmonics of the received echo signal.

16. A method of ultrasound imaging comprising the steps of:

simultaneously irradiating a target with a relatively low frequency ultrasound conditioning signal and a relatively high frequency ultrasound detection signal;

receiving echo signals from the target; and

processing the received echo signals to detect the presence of first structures within the target causing a first magnitude of detection signal echo arising from periods when the conditioning signal is in a first phase and a second, different, magnitude of detection signal echo arising from periods when the conditioning signal is in a second phase.

17. The method of claim 16 wherein the step of processing the received echo signals is adapted to differentiate said first structures within the target whose physical properties change as a function of the conditioning signal from second structures whose corresponding physical properties remain substantially invariant in response to the conditioning signal.

18. The method of claim 16 or claim 17 in which the first structures are contrast agent structures, and including the step of introducing the contrast agent structures into selected locations of the target.

19. The method of claim 18 in which the contrast agent structures are bubbles of fluid.

20. The method of claim 19 in which the contrast agent structures are bubbles of gas.

21. The method of any one of claims 16 to 20 in which the physical property of the first structures that changes in response to the conditioning signal is a size of each of the first structures.

22. The method of claim 21 when dependent from claim 18 or claim 19 in which a physical property of the first structures that changes in response to the conditioning signal is a resonant frequency.

23. The method of any one of claims 16 to 22 in which the conditioning signal has a frequency in the range 10 kHz to 5 MHz.

24. The method of claim 22 in which the conditioning signal has a frequency in the range 100 kHz to 800 kHz.

25. The method of any one of claims 16 to 24 in which the detection signal has a frequency in the range 1 MHz to 50 MHz.

26. The method of claim 25 in which the detection signal has a frequency in the range 1 MHz to 5 MHz.

27. The method of any one of claims 16 to 26 in which the step of processing the received echo signals comprises the step of determining the response of the first structures to positive and negative cycles of the conditioning signal.

28. The method of any one of claims 16 to 26 in which the step of processing the received echo signals comprises the step of determining the response of the first structures to a first excitation signal pulse and to a successive second excitation signal pulse that is a phase-inverted replica of the first excitation signal pulse.

29. The method of claim 28 in which the first and second excitation signal pulses comprise the conditioning signal.

30. The method of claim 28 or claim 29 in which the first and second excitation signal pulses comprise the detection signal.

31. Apparatus substantially as described herein with reference to the accompanying drawings.